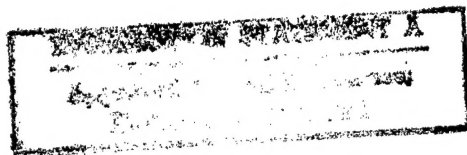


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# USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 83

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10 August 1982

USSR REPORT  
MATERIALS SCIENCE AND METALLURGY

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## ALUMINUM AND ITS ALLOYS

UDC: 669.71'3'721:621.785.78

HIGH TEMPERATURE AGING OF THE ALLOY Al-1.3 at.% Cu-1.3 at.% Mg.

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 53, No 4, Apr 82  
(manuscript received 21 Jul 80; in final form 25 Mar 81) pp 772-779

ALEKSEYEV, A. A., BER, L. B., PAVLENKO, S. G. and KLIMOVICH, L. G.,  
All-Union Institute of Light Alloys, Moscow

[Abstract] A study of the initial stage of high temperature aging of the Al-1.3 at.% Cu-1.3 at.% Mg alloy was conducted to assist in understanding the mechanism of formation of S-phase hardening particles. Mechanical properties, x-ray structural diagrams and electron microscope studies were utilized to generalize a model of structural changes in the initial stage of high temperature aging. The softening in that stage was found to be controlled by diffusion processes with an activation energy of approximately  $120 \cdot 10^{-3}$  J/mol. The initial stage of high temperature aging is accompanied by weakening of the area of diffusion scattering and appearance of characteristic long and short streaks on x-ray diffraction diagrams. The zones corresponding to coherent equilibrium S-phase particles change their form, extending in the  $\langle 120 \rangle_{\alpha}$  direction and contracting in the  $(210)_{\alpha}$  plane. The decrease in deformation stress due to an increase in dimensions of coherent particles in the initial stage is sufficient to explain recovery. Figures 7; references 16: 9 Russian, 7 Western.  
[137-6508]

UDC: 669.71'721'793:539.4016

INFLUENCE OF DEFORMATION METHOD ON STRENGTH OF ALUMINUM ALLOYS WITH  
MAGNESIUM AND SCANDIUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 29 Oct 80) pp 76-79

PANOVKO, V. M. and BYKOV, Yu. G., Moscow

[Abstract] A study is made of rolled and extruded aluminum alloy blanks containing 2 to 8.5% magnesium and 0 to 0.5% scandium by mass. Ingots with a mass

of 0.4 kg were melted in an induction furnace in an atmosphere of argon, homogenized at 430°C, deformed and annealed at 320°C, producing a recrystallized structure in binary alloys and a nonrecrystallized structure in ternary alloys. The thermoplastic treatment conditions selected provided minimum difference between extruded and rolled blanks of binary Al-Mg alloys. Alloying with scandium significantly changes the situation: extruded blanks are stronger than rolled blanks, the yield point depending on the content of magnesium and scandium and reaching a maximum at 2-5% Mg and 0.2-0.35% Sc. The difference in properties of bars and sheets in the ternary alloys is related to the pressing effect or structural hardening. Structural hardening in ternary alloys after annealing is not great, but increases to 100-110 MPa with an increase in applied stress or equivalent accumulated deformation. Figures 3; references 9: 7 Russian, 2 Western.  
[130-6508]

## COATINGS

UDC: 620.197.3

### ANODIC BEHAVIOR OF TITANIUM WITH COATINGS OBTAINED BY ELECTRIC SPARK ALLOYING IN CHLORIDE-ALKALI SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 18, No 3, May-Jun 82  
(manuscript received 12 Jun 79, after revision 26 Jun 80) pp 410-413

RISKIN, I. V., TIMONIN, V. A., GITLEVICH, A. Ye. and MIKHAYLOV, V. V.,  
All-Union Scientific Research Institute for Protection of Metals from  
Corrosion

[Abstract] A study is made of the anodic behavior of titanium with coatings applied by electric spark alloying in order to determine the applicability of these materials as anodes for the protection of titanium from corrosion in chloride-alkali melts. Ti-Ni, Ti-C and Ti-C-Ni coatings with sequential application of TiC and Ni as well as Ti-Co and Ni coatings on the basis of Ti-0.2% Pd were studied. Coatings were about 20  $\mu\text{m}$  thick and covered the entire working surface of the electrodes. Specimens with nickel coating about 200  $\mu\text{m}$  thick were also tested for comparison (coating produced by atomization in a nitrogen-argon plasma). Nickel-titanium carbide-nickel and cobalt coatings applied by the electric spark method produced anode materials resistant to corrosion in chloride-alkali melts at high and variable current densities, capable of protecting the titanium from corrosion. Figures 1; references 14: 12 Russian, 2 Western.

[143-6508]

## COMPOSITE MATERIALS

UDC: 620.172:678.067

### INFLUENCE OF TEMPERATURE ON STRENGTH OF MAGNESIUM-BASED COMPOSITES REINFORCED WITH SILICON CARBIDE FIBERS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 27 Jul 81) pp 358-360

MAKSIMOVICH, G. G., KARPINOS, D. M., FILIPOVSKIY, A. V., KADYROV, V. Kh.  
and GORDIYENKO, A. I., Institute of Physics and Mechanics, Ukrainian Academy  
of Sciences, L'vov

[Abstract] Results are presented from studies of the influence of temperature on the short and long term strength of a composite material based on magnesium, reinforced with silicon carbide fibers. Specimens were tested for short term strength at 293-673°K on a 6-position tensile testing machine, for long term strength on a 12-position radial type installation. In the temperature range studied the strength of the composite is significantly higher than that of the matrix alone. As temperature increases the strengthening effect increases. Analysis of tensile fracture surfaces shows that at all temperatures the SiC fiber separates by brittle fracture, repeatedly at the higher temperatures. The magnesium matrix separated by viscous fracture at all temperatures. The composite materials had high specific strength and were suitable for use at temperatures up to 573°K. Figures 2; references 3: all Russian.  
[140-6508]

UDC: 677-15:620.17

### QUANTITATIVE ESTIMATE OF FIBER COMPOSITE MATERIAL COMPONENT COMPATIBILITY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 82  
(manuscript received 25 May 81) pp 41-45

ZABOLOTSKIY, A. A., Moscow

[Abstract] The optimal fracture mechanism providing slowest accumulation of microfractures and consequently maximum strength of a composite is to be found

in the material with the greatest bond strength between components, minimum fiber softening and matrix embrittlement. Compatibility refers to the capability of the components to form a strong bond at their division boundary without significant deterioration of properties. A mathematical analysis is presented of conditions which tend to reduce compatibility of components in composites. Compatibility improves with an increase in activation energy of fiber softening and with a decrease in activation energy of increasing division boundary strength. The optimal condition of a composite is achieved at the maximum time to failure or maximum permissible temperature. Figures 4; references 4; all Russian.

[145-6508]

UDC: 666.7:661.634:661.55

PHYSICAL-CHEMICAL PROCESSES OCCURRING IN NITRIDE AND OXIDE-NITRIDE COMPOSITES WITH PHOSPHATE BINDERS UPON HEATING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 82  
(manuscript received 16 Mar 81) pp 50-54

KARPINOS, D. M., MIKHASHCHUK, Ye. P., AMIROV, R. A. and SHAYAKHMETOV, U. Sh.,  
Institute of Material Science Problems, Ukrainian Academy of Sciences;  
Bashkir State Pedagogics Institute

[Abstract] This article discusses physical and chemical processes occurring in systems consisting of aluminum nitride plus phosphate binder, aluminum nitride,  $Al_2O_3$  and phosphate binder, silicon nitride and phosphate binder, silicon nitride,  $Al_2O_3$  and phosphate binder when heated in air to 1520°K. The phosphate binder used was an aluminochromophosphate binder manufactured according to technical conditions TU6-18-166-73, plus 85% analytic grade orthophosphoric acid. The studies included thermographic analysis, x-ray phase analysis, IR spectroscopy in vaseline and paper chromatographic analysis. Hardening of composites based on silicon and aluminum nitrides results from chemical interaction of the phosphate binder with the nitrides, the  $\alpha$ -corundum acting as an inert filler. The hydrogen bond is significant in the hardening mechanism of these composites, as is polymerization of the phosphates at higher temperatures. The end product of thermal decomposition of polyphosphates at 1520°K includes aluminum orthophosphate or silicon pyrophosphate depending on type of nitride filler, with a content of 5 to 10% in either case. Figures 6; references 3: 1 Russian, 2 Western.

[145-6508]

## DESCRIPTION OF DEFORMATION OF HYBRID COMPOSITE CONSIDERING FIBER BREAKAGE EFFECT

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 2 Nov 81) pp 233-238

MAKSIMOV, R. D. and KOCHETKOV, V. A., Institute of Polymer Mechanics,  
Latvian Academy of Sciences, Riga

[Abstract] Six groups of unidirectionally boron reinforced plastic differing in volumetric content of organic and boron fibers with identical total reinforcement were tested using flat specimens with gage section 100 x 10 x 2 mm. Differences were found not only in the deformation diagrams but also in the type of failure of the specimens. Failure of the organic fiber reinforced plastic was accompanied by considerable spreading and fanning of the broken ends. Composites reinforced with boron fibers alone broke almost on a plane, with the ends of boron fibers extracted from the matrix of the opposite side clearly seen. The broken specimens were heat treated and the lengths of segments formed due to multiple breakage of boron fibers in the composite were measured. The data produced in the experiments were used to select a calculation scheme to describe the deformation diagrams of the material studied. The equations derived were implemented as an NR-9600 computer program which generated plots of the deformation diagrams and curves of modulus of elasticity of the composites. The calculated deformation diagrams agree qualitatively with the experimental diagrams. The divergence is explained as a manifestation of viscoelasticity of the organic fibers and the binder or loss of bonding between matrix and boron fiber surfaces near the fracture surface. Figures 6; references 5; all Russian.  
[140-6508]

## THERMOMECHANICAL BEHAVIOR REGULARITIES OF SIMPLE COMPOSITE MATERIAL MODELS WITH INTERPHASE LAYER

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 6 Apr 81) pp 225-232

LIPATOV, Yu. S. and BABICH, V. F., Institute of High Molecular Weight Compound Chemistry, Ukrainian Academy of Sciences, Kiev

[Abstract] A detailed theoretical calculation analysis is performed of the specifics of the viscoelastic behavior of composite polymer materials in the



area of temperatures where the binder is in a transient state for 3-component composite models consisting of a high modulus filler, an interphase layer and the remaining portion of the polymer binder. The analysis of temperature variations of  $\tan \delta$  in simple composite material models in the area of the transient state of the binder can be used to understand experimental viscoelastic behavior of actual composite materials. This will be used to continue studies to generate better models and indicates the need for careful interpretation of the results of experimental studies of the viscoelastic behavior of composite materials in the area of the transient state based on qualitative representations. Quantitative analysis of the viscoelastic behavior of the model shows that in materials such as filled polymers the components of solubility and displacement of the maxima of  $\tan \delta$  resulting from changes in interphase layer properties are fully determined by the relationship of concentrations in the interphase layer and in the remaining portion of the polymer plus the difference in their glass points. Figures 5; references 3: all Western.

[140-6508]

UDC: 539.3.001:678.067

#### DEFORMABILITY OF COMPOSITE WITH ELASTIC-PLASTIC MATRIX REINFORCED IN ONE DIRECTION

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 3 Jul 81) pp 217-224

MELBARDIS, Yu. G. and KREGERS, A. F., Institute of Polymer Mechanics,  
Latvian Academy of Sciences, Riga

[Abstract] A study is made of the possibility of determining the elastic potential of a composite with physically nonlinear matrix, reinforced in one direction. Elastic matrix potentials and a composite of a special type were used, leading to a relationship between  $\epsilon$  and  $\sigma$  in the form of an exponential series with respect to stresses. The solution is based on a piecewise-linear representation of the matrix deformation diagram with subsequent application of existing linear structured theories of reinforcement. It is assumed that the reinforcement is a linearly elastic material. The possibility is demonstrated of constructing several calculation curves of deformation of the material and of determining all parameters of the calculation model on the basis of the curves. Figures 4; references 14: 5 Russian, 9 Western.

[140-6508]

## HYDROGENATION OF TITANIUM AND PLATINUM CATHODES UPON ELECTROLYSIS OF SEAWATER

Moscow ZASHCHITA METALLOV in Russian Vol 18, No 3, May-Jun 82  
(manuscript received 17 Feb 81) pp 371-375

MIKHAYLOVA, L. A., KHODKEVICH, S. D., SKURATNIK, Ya. B., YAKIMENKO, L. M.,  
DEMBROVSKIY, M. A., YAKUBENKO, A. R. and SKRYABINA, V. I., Physical-Chemical  
Scientific Research Institute imeni L. Ya. Karpov

[Abstract] This study is intended to develop measures to protect the surface of a bipolar electrode from hydrogenation and corrosion. Two methods of increasing the service life of bipolar electrodes were studied: the use of hypochlorite formed at the electrode to prevent hydrogenation and corrosion; and the use of purer titanium and platinum coatings for direct electrolysis of seawater. Studies were performed with VTl-0 and VTl-00 titanium 1 mm thick as delivered in a temperature controlled 20°C cell without separation of anode and cathode spaces under galvanostatic conditions in simulated seawater containing (g/l): NaCl-27, MgCl<sub>2</sub>-2.47, MgSO<sub>4</sub>-3.26, KCl-0.59, CaSO<sub>4</sub>-1.69, NaHCO<sub>3</sub>-0.09, NaBr-0.08. The titanium was etched in sulfuric acid 800 g/l, 80°C, 20 minutes before application of the platinum coating. The VTl-00 undergoes twice the hydrogenation experienced by VTl-0 under the experimental conditions. Platinum coating decreases hydrogenation, but the platinum coating breaks down rapidly with cathodic polarization and thus does not provide the needed increase in service life. A sublayer of ruthenium oxides beneath the platinum coating applied during heat treatment improves the resistance of the platinum coating, decreases hydrogenation of the titanium base and may increase cathode service life. Figures 3; references 10: 9 Russian, 1 Western. [143-6508]

## FERROUS METALLURGY

### METALLURGISTS CITE MISMANAGEMENT IN THE SUPPLY OF MATERIALS

Moscow MATERIAL'NO-TEKHNIЧЕСКОYE SNABZHENIYE in Russian No 1, Jan 82  
pp 19-24

[Article by K. Mikhaylov: "Being Concealed for Objective Reasons; Why Minchermet Fails To Fulfill Its Contractual Obligations"]

[Text] Many plants of the USSR Ministry of Ferrous Metallurgy [Minchermet] have not fulfilled their production plan in the allotted time. Why? Because there is no metal. This was explained in exemplary fashion by the Deputy Chief of the Planning and Economic Directorate of Minchermet, V. S. Olefir.

This is not a paradox and not a pun. In general, this is the way it actually is. There is not enough cast iron, there is no steel, and this means that there is no rolled stock. Pipe billet plants are not provided [with metal], and the pipe production plan is not fulfilled. The natural question arises: is the lack of metal the cause or the effect of the poor operation of the ferrous metallurgy branch?

What Kind of "Power" Do the Metallurgists Lack?

Workers of Minchermet see as one of the principal causes of failures in the production of metal to be the lack of iron-ore raw materials, alloying materials and coke. Undoubtedly, the lack of these materials makes the work of the metallurgists difficult. But are these causes really global?

The total level of nonfulfillment of the production plan does not exceed 2-3%. Nonfulfillment of specific orders of users, as a rule, is 3-4%, and the under-supplying of economic sections [profiles] is 20-30%. Why has this occurred? If there is not enough of something, then there is not enough. And here some kind of differentiated deficiency is found.

An inspection of plants of the largest metallurgical "granary" in the world, the Ukraine, was recently conducted. A considerable part of the cast iron,

finished rolled stock of ferrous metals and steel pipe is produced here. Therefore, the extent to which USSR Minchermet's plants fulfill the USSR plan for producing metal in many respects predetermines the supply provision of the consumers of the country with the valuable structural material. As it was revealed in the course of the inspection, the main reasons for nonfulfillment of the plan for producing metal for ten months were the serious shortcomings in the organization and preparation of production at plants of UkSSR Minchermet, the superplan downtime of equipment due to frequent breakages and breakdowns, and interruptions in the providing of raw materials due to disruptions in cooperation within the ministry.

The downtimes not provided for by the plan are great, for example, at the Krivoy Rog, Kommunar'sk and Makeyevka metallurgical plants. To blame for this are the low level of technological and labor discipline, shortcomings in the control of production, and the low qualification and high fluctuation of the workers and engineering and technical personnel.

This is the position in the subdivisions which provide the plants with coke and manganese. As a result, the production plan is not fulfilled. Metallurgists experience a chronic deficiency in these materials. The production of coke is held back by a shortage in coking coal. It would seem that Minchermet would take all measures in order to incorporate, as soon as possible, the achievements in science, which permit liquidating the shortage in raw materials, and to finance such operations. But this is not always done.

Science has proven that coking coal can be partially replaced successfully by molded and briquette coke. This makes it possible to increase the portion of noncoking coal in the charge by up to 30-40%. It is clear what tremendous reserves are concealed in the utilization of such a method. However, Minchermet alludes to the fact that for the improvement of briquetting processes there are no trained personnel or specialized research and design organizations, and equipment is not being produced. And who is to blame for this but the ministry itself? The staff exists in order to anticipate and work in calculating future prospects and in being prepared in good time to solve the complex problems.

Many metallurgical plants of the country consume considerably more cast iron for the smelting of steel than is provided by the standards. One of the reasons for this, as they explain at Minchermet, is the shortage of steel scrap. The explanation is not beneath criticism. The matter is not in a shortage of scrap metal but in the substantial shortcomings which occur in its procurement.

The Karaganda Metallurgical Combine is thousands of tons behind in providing rolled stock. Together with other causes which interfere with the fulfillment of the plan, we also name here the shortage of scrap metal. Meanwhile, in Kazakhstan there are large reserves of scrap. Only it is not at the

storehouses of Vtorchermet [Plant for the Processing of Secondary Ferrous Metals] but on the farms and at the plants. With the correct organization of procurements, it would be possible to provide not only the combine with scrap but also the other plants. However, the procurement plan for scrap metal in the republic has not been carried out systematically.

The Kuznetsk Metallurgical Combine does not lack scrap metal. Half-empty railroad cars go to the plant. They are loaded with bulky and unbaled metal. Forty thousand over-plan tons of such scrap were delivered here during six months of the past year, deliveries of fagots, however, were thirty thousand tons under the plan.

The facts show that a shortage of metal scrap occurs due to the poor operation of Vtorchermet. The amalgamation [union] operates using antiquated methods. The procurement does not include an enormous quantity of scrap which has accumulated at the plants and clutters up the fields. This scrap deteriorates and buries itself into the ground. It is radically necessary to restructure the operation of Vtorchermet. Only then will metallurgists be regularly provided with scrap.

Plants of Minchermet systematically do not fulfill their contractual obligations and orders. This is a result of the failure to fulfill production plans. Things are especially bad with output of economic but labor-consuming types of production.

For example, the Zhdanov plants "Azovstal'" and Imeni Il'ich fulfilled the production plan of finished rolled products in seven months of last year by 97 and 99 percent, respectively. At the same time, at the first plant the production plan of heat-hardened steel was fulfilled only by 43% and that of sheet normalized steel, by 67.5%.

The production plan of rolled products of low-alloyed steel is considerably underfulfilled. The Krivoy Rog metallurgical plant, in the first half of last year, underproduced 172,000 tons of labor-consuming sections of rolled products because of intraplant organizational and technical breakdowns.

The fulfillment of the plan for producing economic sections has been disrupted at the Karaganda Metallurgical Combine, the Novolipetsk metallurgical plant and many others. From half-year totals, out of the 27 items of economic forms of rolled stock, the assignment was filled in only 14 of them. This is indicative of the fact that the "gross output", the fulfillment of the plan in quantity and not in quality, all the more hangs over the work of the metallurgical plants.

In order to justify the nonfulfillment of the assignments in the production of economic sections of rolled stock, the metallurgists cite the shortage in

ferroalloys and other alloying additions. Actually, there is no shortage in such materials. The fact is that the metallurgists themselves are not coping with the tasks in increasing their output. Nevertheless, references to the absence of alloying materials and additions are not groundless, and the deficiency in these raw materials is much less than the underfulfillment of the orders. The providing of the plants of UkSSR Minchermet with ferroalloys consisted of 96% of the quota, and fulfillment of the production plan of rolled stock from low-alloyed steel was, on the average, 79%.

The deficiency in raw materials requires an especially prudent handling of those resources which are available. However, practice shows that at plants of the branch the raw materials are not used by assignment and are poorly stored. At the Zhdanov plant Imeni Il'ich, for example, as a result of incorrect storage, the ferrotitanium is mixed with the copper. Gor'kiy metallurgical plant, during eight months of last year, overconsumed more than 1500 tons of ferroalloys. More than 80 tons of ferromanganese became worthless here. At many plants the technology of the use of these alloys has been disrupted. This results in great losses in the valuable raw materials.

Undoubtedly, the problem of the ferroalloys is serious. But Minchermet itself is slow in solving it. Meanwhile, there is an effective way, and this is the production from slag wastes. Industrial methods are being developed for obtaining, for example, ferrosilicon from liquid slag, which is found in enormous quantities at thermoelectric power plants. For more than two years, the Zhdanov blast furnace operators and foundry workers have been producing cast iron and steel by introducing into the melt granulated ferrosilicon from the Starobeshevo GRES [State Regional Electric Power Plant]. Production of several thousand tons of such alloy per year has been started at Starobeshevo.

Calculations show that five GRES's in the Ukraine alone can produce more than 30,000 tons of ferroalloys in one year. Sources of raw materials are literally at hand for the metallurgical plants. Next to the plant Imeni Il'ich is the Uglegorsk GRES, the plant Kommunarsk - the Voroshilovgrad GRES, and the plant "Krivorozhstal'" - the Krivoy Rog GRES-2.

It would seem that the Minchermet would be more interested than all the others in the increase in the production of ferroalloys from wastes. In fact, this opens up an enormous source of replenishment of reserves of the valuable raw material. However, the ministry has not achieved a solution to this important problem. For several years there have been futile bureaucratic arguments between the USSR Minchermet and Minenergo [Ministry of Energy] of the republic about who is to produce these ferroalloys. And things have not changed.

The narrow departmental approach impedes the solving of other problems associated with the production of scarce forms of metal. Now there is a shortage of steel pipe. This shortage could be reduced through the use,

where technically possible and economically expedient, of pipes made from other materials, for example, from slag glass ceramic. Such pipes are needed, let us say, by the Krivoy Rog concentration combine, which provides the "Krivorozhstal'" with ore. These pipes can be manufactured on the basis of blast-furnace slag, which is available at the "Zaporozhstal'".

It is as if, everything being at hand, the matter depends on implementing the available possibilities. However, at the "Krivorozhstal'" they are not about to be engaged in this. Here they consider that such production is not necessary to the plant. And, meanwhile, articles of slag glass ceramic have passed an experimental check. The USSR State Committee on Science and Technology has recommended that Minchermet start the production of such pipe. This would make it possible, on the basis of blast-furnace slag, to produce pipe for all the ore-extracting enterprises of the country. However, in spite of the fact that a plan of an experimental-industrial works on the production of pipes from slag glass ceramic was already prepared, Minchermet obtained an exclusion of these operations from the plan.

At Minchermet a great many discussions are being conducted on the shortage of qualified workers and engineering and technical personnel. What is being done to solve this problem?

The fluctuation in manpower in the branch did not just begin today. This disturbing symptom should have long ago disturbed the leaders of the branch and compelled them to take effective measures and tighten up the supply system which provides the main production--the by-product coke industry and ore-extracting sections. However, this was not done in time. Only the "main conveyor" of metallurgical production was being developed at a rapid rate, and only the supernarrow sites were mended in the supply system.

Now we must pay for such shortsightedness. Only a combined solution to the problems and a coordination of all the links of the metallurgical production, from the mining of the raw materials to the yield of high-grade metal, into a single, balanced economic mechanism, can help to eliminate the lag.

Many problems are being solved in a combined manner now. For example, plants of Minchermet supply not only users from other branches, but also partners in the intraministry cooperation. This, naturally, causes a "boomerang" reaction. Let us say that a plant underprovided stock to an allied supplier, i.e., the supplier did not obtain the needed rolled stock from the plant. A chain reaction of disruptions is started. And this is far from always being caused by objective reasons.

Here was such a case. Instead of the 40,000 tons of metal recorded in the yearly plan, the Cherepovets metallurgical plant supplied only 480 tons to the Chelyabinsk metallurgical plant. And it proved to be unusable. Minchermet



explained this by objective reasons--the complexity of development of the technology of the production of stainless steel. But all this was found to be a myth, which was dispersed when workers from the Urals brought an action to Gosarbitrazh [State Arbitration Commission] against their business partners. As was explained at Gosarbitrazh, the Cherepovets metallurgists were not guilty and, therefore, were not fined. The fact is that the "Soyuzmetallurgprom" and "Soyuzspetsstal" all-union industrial unions had confirmed the specifications for supplying semifinished rolled stock of stainless steel only in 1981.

It appears that the point is this! For several years the Chelyabinsk plant has been attached to the Cherepovets plant, but there are not even approved specifications for the production of stainless steel available there. In essence, the Ural workers are dealing with an unrealistic supplier. Thus a disruption of the supplies is a foregone conclusion.

It is paradoxical but nonetheless a fact that tens of thousands of tons of semifinished rolled stock of stainless steel, manufactured in Chelyabinsk, are being shipped to Verkhnyaya Salda. And it is precisely such rolled stock which the Ural workers should obtain from Cherepovets. Are these really objective reasons? No, of course not. This is an objective lack of organization and lack of reasoning of actions.

Often metallurgical plants are allotted funds for metal which are much less than what is required to fulfill the confirmed production plan. Workers of Minchermet cite, as a rule, the fact that USSR Gosplan does not provide enough capital. Let us assume that this is so. But why does the ministry fail to achieve a balance in the production plans and material supply? Or does Minchermet not have a voice in the matter? If its workers are assured of the correctness of their calculations and can convincingly prove them, why do they not require corrections in the plan, bringing it into conformity with the available resources? It is obviously not clear to the ministry that a strong solution which is groundless economically can bring nothing except harm. The imbalanced character "crops up" at the most inappropriate moment, and everything must point equally to a correct solution. But this already requires much greater expenditures. It was necessary to raise the question of the balancing out of the production plans and supply provision in the preparation of designs of these plans. Then it would not be necessary to solve them at the last moment.

Obviously, the problem is not in the shortage of the initial materials. Of course, their deficiency definitely affects the nonfulfillment of the production plans and output of the efficient sections. But, this is still not the main reason; rather it is only a means for justification. The real reasons are an imperfect economic mechanism, imperfect methods of planning the production of metal, and an economic lack of interest in the manufacture of labor-consuming sections of rolled stock and pipes.



## Only in the Indices Does It Matter?

Perhaps there has not been another such index into the address of which would be expressed so uncomplimentary words as the ton. For ten and a half years now discussions have been raging over whether the ton or the meter will be awarded a "name-day". These debates have been in vain. For a long time now the production of pipe, for example, has been planned in both tons and meters. The "metric area", it seems, is one which is necessary to the consumer. But the introduction of this index did not solve the problem. Up to the present there has not been enough pipe of efficient grades.

What is the matter? Why aren't metallurgists interested in producing efficient labor-consuming metal products? The fact is that the existing system of planning and estimating the activity of the metallurgists does not account for the qualitative indices. As before, metallurgists are found in the captivity of the cursed "gross output." At the November (1981) Plenum of the CPSU Central Committee, the General Secretary of the CPSU Central Committee Comrade L. I. Brezhnev, said in his speech: "The congress has proclaimed a slogan: 'Economics should be economical.' The entire economic mechanism should be brought into conformity with this requirement. But it is necessary to recognize that in proper measure this has not yet been done... Therefore, it has still been impossible to get rid of such indices, which, essentially, explains the waste. We have in mind the notorious "gross output," calculated in tons or rubles..."

Today metallurgists' wages depend on manufactured tonnage. The whole system of material interest is attached to it. The output of efficient, more labor-consuming sections in the full sense "costs them a pretty penny," and tonnage serves. And this is one of the reasons for the high fluctuation of personnel in the branch. This is why there is an unwillingness of the metallurgical plants to produce more labor-consuming rolled stock.

This problem can be effectively solved only with a combined approach to the matter. First of all, it is necessary economically to interest the metallurgical plants in expanding the grades and improving the quality of the metal products. In order to create favorable conditions for introducing economic sections, it is time to break the connection between tonnage indices of operation of the plant and the degree of material recompense of the metallurgists. The level of the national economic effect and the complete fulfillment of all the orders are what should determine the quality of the work of the metallurgical plant.

Recently introduced has been a regulation on the order of accounting of the fulfillment of orders and obligations in deliveries of products. The purpose of the regulation is to have a stimulating effect on the fulfillment of contracts and the production of efficient sections. But a similar regulation,

admittedly less complete, was in effect earlier. However, it did not provide special gain. The fact is that its effect extends only to a narrow group of management and engineering and technical workers. With the failure to fulfill contracts and orders within limits established by the regulation, they lose only an insignificant part of the gratuity and sometimes manage to obtain all of it. A disruption of the overall production plan would lead to a complete loss of the material remuneration. Therefore, the majority of the metallurgical plants proceed along the easiest path: they try to "drag out" the plan by means of loading down the orders.

The plant Imeni Il'ich disrupts deliveries in conformity with the orders and does not fulfill the production plan of economic types of rolled stock. For six months of last year implementation of deliveries according to orders consisted of 96.2% less than what was planned. Instead of cold-rolled commercial sheet with a thickness of 0.5-0.8 mm, half of the orders were shipped with a larger thickness. This resulted in an over-expenditure for the consumers of more than five thousand tons of metal. Nevertheless, leaders of the plant are constantly receiving bonuses. Indices established by the new order of accounting of the fulfillment of orders and obligations in deliveries are, undoubtedly, more perfected than those in effect earlier. Nevertheless, they need to be reinforced.

The efficiency of the activity of metallurgical plants depends, first of all, on the economic personal interest of tens of thousands of qualified workers: steel founders, rollers and casters. The "ton" is not aimed at the metallurgists to achieve the best national-economic results. An index which would unite the interests of the consumers and suppliers is needed. Ultimately, it is necessary that the supplier fulfill his order to the consumer, and the supplier must be compensated for all his labor and other expenditures. Then all the orders will be profitable for the supplier.

The new index must consider the labor intensity of the manufacture of specific grades. In this way everything will be equal to the metallurgists, whether a light or heavy section is manufactured, and they will have a personal interest in working on the orders of consumers.

Proposals on the introduction of the index "adjusted ton" are now being developed. It is proposed that by means of it, it will be possible to enlist the personal interest of metallurgists in manufacturing rolled stock of improved quality and to plan more clearly the operating time of the rolling mills, taking into account the labor intensity of the production of a specific grade. State interests require that this index be tested as soon as possible under industrial conditions at metallurgical plants. Then the problem as to its general use can be solved. However, this work has been dragged out intolerably.

Nevertheless, even if the index proves to be highly efficient, its use will not completely solve the problem of the metallurgists. Some see it as a panacea. But no index, except a superperfect index, can be all-powerful. Therefore, to make any one index absolute, and to impart to it fund-forming rights, as a rule, will mean that the plants will try to attain their achievements at any price, even at the expense of others. If we speed up only the efficient sections, then those which are now sufficient, tomorrow will become deficient.

Dozens of regulations on the rewarding of engineering and technical and management workers are in effect at plants of Minchermet. Nevertheless, an effective stimulant to the fulfilling of production plans and delivery according to the agreements has not been forthcoming. The same thing also occurs in other ministries. Undoubtedly, the ordering of the system of stimulation with the framework of one ministry will not have a great effect. This must be done everywhere. A complex or system of interconnected indices is required, and above all it will be necessary to create such organizational and economical conditions which would promote the fulfillment of these indices.

In solving all these problems, much depends on the agencies of USSR Gossnab [State Commission of the USSR Council of Ministers USSR on Material and Technical Supply]. They are obligated to achieve the correct planning, the rational loading of the available mills and the optimal placing of the orders. However, shortages are still great in this work.

The plant should be equally interested in fulfilling all orders, including the most labor-consuming. Now with the loading of the mills, the labor intensity of the manufacture of a specific grade is not considered. The loading of the metallurgical units is carried out according to averaged indices, taking the average productivity into account, when there is still no production plan. The plants receive a specific portfolio of the specified orders much later. And here it appears that they do not produce certain sections, and it is necessary to transfer this assortment to other plants.

It can happen that with respect to tonnage the plant would be as if it were loaded but not with respect to time: the less labor-intensive grade would be supplied. And it can happen in the opposite way, when in order to fill the orders the plant must work more than 24 hours a day. With such an overload to the plant, in essence a disruption of the plan is predetermined already in this stage. Where one is only concerned here about orders, at least the gross output is provided!

This was the case in the makeup of the design of the plan for 1981. In conformity with design, the plants were loaded. In November and December of 1980, the metallurgists received the plan, which exceeded the potentialities of the mills by a million tons. Only six plants are producing the grades indicated

in the plan. According to them, an additional million tons were scattered about. To a definite extent, this also promoted the disruption of deliveries of the economic sections.

Agencies of USSR Gosplan must consolidate the planning discipline and strictly monitor the observance of the regulation on the order of fulfillment of deliveries, taking the orders and contracts into account. But there are cases when they approach the matter from narrow departmental positions and administer the plants which disrupt the fulfillment of the contractual obligations with respect to deliveries.

Many consumer plants complain that the metallurgists of the Ukraine do not provide them with enough of a large quantity of rolled stock. At the same time the republic consumers receive the metal punctually. For example, organizations of UkrSSR Minpromstroy [Ministry of Industrial Construction] were supplied with 88.5% of the ordered metal and those of the union Minpromstroy, 81%. Delivery is fulfilled to the Minmontazhspektstroy [Ministry for Installation of Special Construction] at 97.8%, and to organizations of the union ministry in other economic regions by only 73.1%. Of course, it is not only the metallurgical plants who are to blame for this. In fact, the planning of deliveries depends on agencies of USSR Gosplan. But its workers did not show the proper demand to the republic metallurgists and did not ensure the timely delivery of rolled stock to other economic regions in conformity with the contracts and orders.

Today the output of certain efficient sections, in particular, products of low-alloyed steels, is held back to a certain extent due to the fact that the metallurgists are not loaded with orders. And there are no orders because there is no demand: the consumers are ready and do not know about possibilities of efficient forms of rolled stock. This is a result of the weak work of the Soyuzglavmetall [Main Administration for Interrepublic Deliveries of Metal Products] with the consumers.

Undoubtedly, the problem of providing the national economy with metal depends not only on the metallurgists. To no less a degree it should be solved in machine building and capital construction. Enormous reserves are concealed here. But they are being used poorly. The consumer branches require more and more metal, and all the more it is turned into shavings and packed into unjustifiably heavy structures. This is why, in spite of the fact that the proportion of the efficient forms of rolled stock in the total volume of the output is being steadily increased, the utilization factor of the metal does not grow. Of course, this does not remove the responsibility from metallurgists in the shortage of efficient sections of metal. The ferrous metallurgy branch is not an isolated system. It is connected by thousands of "threads" with other branches of the national economy. Any failure in the production of

metal is answered by a boomerang in the work of the suppliers. Disruptions are caused mainly by shortcomings in the organization and economical mechanism. But these important reasons for the nonfulfillment of the plans are skillfully concealed beyond the fencing of the actually existing difficulties, and it is hard to understand where "input" and "output" are. For a long time now it has been known that each "objective" reason has a specific name, patronymic and surname. It is necessary here to make it so that each worker, from working man to minister, will bear a personal responsibility for the position of affairs in his strictly defined section. And this means not just in Minchermet.

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## METAL PRODUCTION, DISTRIBUTION AND UTILIZATION DISCUSSED

Moscow SOVETSKAYA ROSSIYA in Russian 18 Apr 82 p 2

[Article by V. Kulikov, deputy chairman, USSR State Committee for Material and Technical Supply: "Economic Strategy. We are Completing Operation 'Metal'"]

[Text] First, of all, I would like to note the timeliness of the questions advanced by the newspaper. The discussion which took place on the pages of SOVETSKAYA ROSSIYA encompassed the most important problems related to the production, distribution and utilization of metal. The interest with which the readers analyzed them is explainable and natural: today there are no plans or national economic programs whose embodiment in practice is not in some way related to the use of metal.

Anyone who attentively traces the course of economic construction knows that in the last three years the production of finished rolled metal product has not been increased. Last year, for instance, the USSR Ministry of Ferrous Metallurgy fell short of the plan by 6.6 million tons. In sum, when the absolute figures for the national economy are compared, 2.7 million fewer tons of rolled product were produced than in 1978. The situation in the first quarter of this year was somewhat improved.

It should be kept in mind that no two metals are alike. There are some brands whose use saves the national economy 30-40% in rolled metal product. Let us try from this qualitative position to evaluate the work of the USSR Ministry of Ferrous Metallurgy. While last year's plan in total metal production volume was 6% short, in economical articles, specifically, in low alloyed steels, it was 29% short. The lag was 5 million tons. Receiving less than an effective production, the consumer could not fulfill the minimum assignment for metal savings of 663,000 tons.

What is the cause of these interruptions? As strange as it seems, it is not beneficial for the metallurgical enterprises today to turn out economical types of production. The Novolipetsk plant, for instance, fulfilled the plan for the production of finished rolled product by 98%, but in the production of

economical rolled product from low alloyed steel, by only 58%. There are analogous ratios in other plants as well: in the Zapadno-Sibirsk, the Chelyabinsk, Azovstal' and the Karaganda Combine. The fact is that ferrous metallurgy for a long time has been developed under the determining influence of such a gross quantitative indicator as "tons of output production". Both the economic indicators and the level of the material reward to the workers and the place on the board of honor were functions of this. The newspaper in the article "Shortage with an Excess" told in detail what led to such a system. It was the orientation to the ton itself that led to the deterioration in the situation and created the actual deficit.

There is only one way out of the present situation: as the authors of the articles "Dispute in the Hot Shop" and "Stimulus against Shortage" correctly write, through a fundamental change in the system of plan indicators in the metallurgical industry. In my opinion, the following is deserving of attention as a variant to the solution of this economic problem: to plan the production of rolled product and its delivery to the enterprises, not in physical tons, but in tons which account for labor intensity. The fact is that the effective shapes are 25-30% more labor intensive than the conventional ones. In order to stimulate their production, it is proposed to equate one ton of economical rolled product to 1.3 tons of the conventional, let's say.

What benefit would the implementation of this proposal bring? Primarily, the interest in the production of specifically that metal which the national economy needs most will grow in the enterprises. After all, in this case, their additional expenditures on the production of the labor intensive manufactured articles will be compensated for. The requirement for transport means for the transport of the metal and its wastes will cease to be necessary.

The discussion developed in the pages of the newspaper affirms the necessity for the introduction of this variant into practice. I would like to report that a resolution has been adopted by the USSR State Committee for Material and Technical Supply, the USSR State Planning Commission and the USSR Ministry of Ferrous Metallurgy on the planning and evaluation of assignment fulfillment for the production of rolled products and steel pipes taking into account the labor intensity of their production at 16 metallurgical enterprises. According to the preliminary calculations of the USSR State Planning Commission, the national economy will receive an annual savings on the order of 500,000 tons of rolled product. And I stress that this is without any additional capital investments.

It goes without saying that such results will not be achieved immediately. Therefore, even today, it is now time to make efforts to conserve and to rationally expend the volume of metal which the USSR Ministry of Ferrous Metallurgy is now producing. Ultimately, it will be possible to increase indefinitely the production of the rolled metal product, but there will never be enough of it if we do not train every factory to use it economically.



The following curious fact attests to the correctness of such an approach to the utilization of metal. In the period from 1973 through 1980, the production of rolled product in the country, as I have already stated, was not expanded; nevertheless, the total production volume of machine building and metal processing grew by 21%. The output of rolled product was essentially not increased either, but the production of machine building again grew by 6%. How is this possible? On one hand the shortage is apparently present and on the other, the main metal consuming branch of the economy is growing without stop. Such a paradoxical situation is explained by the fact that the branches of machine building have begun to persistently reduce the content of metal production. For instance, in the electrical engineering industry, a quite efficient method of functional cost analysis for articles is being widely used. As a result, it has become possible to reduce the metal content of production by 20-30% or more, without a deterioration in the quality of the product. Well known are the experiences of many enterprises of other branches, which have been able to achieve an absolute reduction in the requirement for metal with an intensive growth in the volumes of finished production. Thus, for example, the Leningrad Elektrosila Association of the USSR Ministry of Power Engineering Machines took on the task of reducing the requirement for rolled metal product by 3000 tons and to increase the production output by 20% in the 11th Five-Year Plan. There are more of these labor collectives which are on the forward edges in the struggle for conservation.

In conditions of the reorientation of the national economy toward an intensive path, the development of a rational and economic program for the expenditure of metal is one of the most important problems. Its solution requires, if one can say it in this way, a specific psychological restructuring. In fact, the production of metal in the past in our country was continuously increased: in the current periods, the increment was 16-20 million tons. Such growth became the norm. And when the situation has changed somewhat, naturally, certain specialists are suddenly speaking about the shortage of the very same rolled metal product. Meanwhile, the essence of the problem, I am convinced, is not so much the shortage of the metal, as the inability to create conditions to reduce the metal content of production. Genuine difficulties with the metal and genuine inertia of practice must be overcome. The most important thing should not be the quantitative increase in the rolled metal product, but its careful and economical expenditure.

I would like especially to cover the proposals expressed in the article "Dispute in the Hot Shop." Turning to the USSR State Planning Commission, the author proposed, specifically, to halt the quite common practice of planning "from the achieved level." In fact, the most important thing today is to constantly expand the kinds of metal produced and to increase its quality. In other words, an increase in the production of the rolled metal product cannot be a goal in itself; the factories of the USSR Ministry of Ferrous Metallurgy must be primarily oriented toward the constant growth in the qualitative relation of the requests of the user branches.



In turn, the metallurgical enterprises must develop programs of sequential change in the structure of the production of their output, in which the promises of scientific and technical progress in machine building and construction would be considered. What does this mean? Let us say that power machinery production is today on the threshold of major changes. In the near future the enterprises of this branch will begin to design and produce the so-called cryogenic turbine installations. They differ from conventional ones in that much less metal is required for their production. This detail is extremely important and, in compiling a long range plan, must be taken into consideration by the enterprises of the USSR Ministry of Ferrous Metallurgy. This is because it is impossible to construct cryogenic turbine installations from the conventional rolled metal product. Another metal is required and people must be trained in its production.

The next item to which the authors of many articles directed their attention is related to the interrelationships between the producer and consumer enterprises. This is no accident, since today their interrelationship in many ways is imperfect. For many years the practice was commonplace that conditions are dictated not by the requestor, but by the producer. This method is in operation even today. There are often cases when metallurgists confront the consumer with a change in a product included in an order. In regard to this, I would like to report the following: the directive bodies have made a strict decision which forbids the production of a replacement brand without the agreement of the requestor. Strengthening the control over the observance of this immutable rule is being demanded by the territorial organs of the USSR State Committee of the Council of Ministers for Material and Technical Supply.

The authors of the article "Stimulus against Shortage" posed an important problem: the quality of the plans for the use of metal being adopted today. Until recently, the assignments to reduce the metal volume of machine building products were not established for anyone. Such a situation tied the hands of those who in light of the agency interests refused to introduce wasteless technology. It is precisely because of this that 8 million tons of metal go into shavings in the country each year. An operating system of planning and production of corrosion resistant rolled metal product has not been stimulated. The annual losses to corrosion are 15 million tons. Today, planned assignments are being introduced to reduce the metal content of articles. But it is not possible to limit ourselves to these. It is apparently necessary to create an order in which tangible sanctions would be imposed on the consumers who exceed the standards for the expenditure of metal. Today, appropriate measures are being developed which will become a barrier on the path of these losses: enterprises will pay for any overexpenditure of material resources by increased prices. Such strictness is required, since no matter how ferrous metallurgy develops, we will always suffer a shortage if we do not learn to carefully and rationally use it. In the article "Superfluous Weight" it is correctly noted that enormous quantities of metal are being lost because of waste and the

absence of well thought-out pattern cutting. Data are cited that in the Sverdlovskaya Oblast, for instance, 26 plants did not comply with established standards and allowed the overexpenditure of 27,000 tons of rolled metal product for this reason.

Financial sanctions for overexpenditure will force many managers to think about an increase in the metal utilization factor. What should be done first? In all probability, it is to expose those articles and parts in which the metal utilization factor is very low and to create conditions for its increase, without delay in each enterprise and with the help of a special engineering program.

Just what are these conditions? Primarily, it is necessary to reexamine the existing processing technology, to identify possibilities for replacement of obsolete equipment and to expose ways to produce products with lower metal volume. In this, everything has significance, even the metal storage conditions. People often forget about this, but it is precisely here that enormous losses are allowed. Even at "AvtoVAZ", a high level enterprise, more than 5500 tons of sheet steel and over 2000 tons of steel strip were lost because of poorly organized storage, as a test of the USSR State Committee for Material and Technical Supply showed. It is estimated that the state must expend 2000 rubles of capital investments per ton of rolled metal product. Does it have to be demonstrated that expenditures to improve storage are in no way comparable with these expenditures?

Beginning next year, in accordance with the resolution of the CPSU Central Committee and the USSR Council of Ministers "About Increasing Operations to Conserve and to Rationally Use Raw Materials, Fuel and Energy and Other Material Resources" a new indicator will be introduced into the planned assignments of the ministries: assignment for cost and a limit on material expenditures (in terms of money per unit of production) included in it. It will help to objectively evaluate the operation of all the links of the national economy, from the moment of metal production until its use. The limit makes it possible to control, on the one hand, the level of cost and on the other, the degree of the effectiveness of the use of the material resources. Also being introduced starting in 1983 is a new system of material stimulation in which 75% of the conserved resources will be directed toward encouraging exemplary workers. Moreover, the observance of the limit to material expenditures will become a condition for the awarding of prizes to the managers of the enterprises and the engineering and technical workers.

Summing up what has been stated, I would like to isolate the main point: by increasing the production of effective types of rolled metal product, it is also required to reduce the metal content of articles and to create conditions for its rational expenditure. The unity of these requirements and their implementation will make it possible not only to conserve metal, but also to manufacture

products of greater and better quality. In this regard, the planning of the use of metal should be considered. But not with the help of numerous indicators. It is sufficient to link the planned growth in the results of production and the volumes of the requirement for metal. Let us say that a machine building plant increased the increment of pure production by 1%; in this case, it can fully count on an "addition" of rolled metal product of 0.25%. In other words, the relation between the growth in the results of production and the requirement for rolled metal product must be "four to one". With such an arrangement, any ministry will strive to develop and use rigid expenditure standards.

Our economy is full of forces and enormous capabilities. The realization of the available resources depends on economic activity directed at conserving material and technical resources. It is impossible to delay. As Comrade L. I. Brezhnev said in his address to the 27th Trade Union Congress: "We do not have time to vacillate. We must work, we must get down to business."

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## IMPROVED SCRAP METAL COLLECTION, PROCESSING URGED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 Apr 82 p 2

[Article by A. Voronov, USSR deputy minister of ferrous metallurgy: "Second Turnover of Metal"]

[Text] More than 5 billion rubles worth of various capital and consumer goods were produced in this country during the 10th Five-Year Plan on the basis of utilization of secondary raw materials. The difference in the cost of primary and secondary raw materials exceeds 2 billion rubles. The search for raw material resources is continuing in the 11th Five-Year Plan. Last year one out of every three tons of steel, one out of every four tons of cardboard and paper, and one out of every five tons of nonferrous metals were produced or, more accurately, reproduced from waste materials.

The Soyuzvtorchermet All-Union Production Association, which is celebrating its 60th anniversary, is solving the problem of reusing waste materials in the iron and steel industry. A fine job is being done in this area by the procurement and processing people in Chelyabinsk, Kurgan, Orenburg, Donetsk, Voroshilovgrad, Moldavia, Chuvashia, Kabardino-Balkaria, and Moskovskaya Oblast. Metallurgical workers and machine builders are continuously receiving above-target raw materials, while carryover stocks of prepared scrap have increased to 24 days. This makes it possible more efficiently to maneuver resources.

We cannot be satisfied with this, however, for this year approximately 50 million tons of scrap and waste are to be procured, and 28 million tons processed. It is virtually impossible to recycle them without subcontractors. Many ministries are reorganizing operations and organizing the collection, separating, storage and delivery of metallurgical raw materials in a stewardly manner. The best include the Ministry of Railways and Ministry of Civil Aviation, as well as certain machine building ministries.

A program for retooling Vtorchermet enterprises is being carried out, and new shops and equipment are coming on-line. In the last year alone facilities designed to prepare more than 1.6 million tons of scrap for remelting have gone into operation.

The growth of facilities this year amounts to one and a half million tons of capacity. Two thirds of new facilities construction will be handled internally.

A new shop in Elista, capital of the Kalmyk ASSR, has already gone into operation, as well as the renovated base shop of the Leningrad Vtorchermet Association. Shops in Chirkent and Stavropol' and the Vtorchermet plant in Murmansk will come on-line by year's end.

With the assistance of the Ministry of Machine Tool and Tool Building Industry, we are continuing to improve machines for baling and cutting metal, and we are developing means of cleaning cut scrap. One new step forward, for example, is the first Soviet-manufactured 400-ton power-driven shears. Their design is completed now, and they are about to go into production. A unit for breaking lightweight scrap has also proven effective.

Large quantities of chips -- more than 7 million tons each year -- are generated at metalworking enterprises. A shop for hot-baling continuous chips is under construction at the Kolomna Vtorchermet Plant in Moskovskaya Oblast for more efficient utilization of chips, and a hot method of degreasing broken scrap is being studied.

Units for higher-quality processing of metallurgical raw materials have also come on-line at our subcontractors' facilities, and more is being recycled. But does this mean that everywhere metal scrap is being treated in a thrifty and good-management manner? The answer is no. Too much is lost by the geologists and construction people, in motor transport and in agriculture. Economists have calculated that each year approximately a million tons of scrap metal accumulates just on our farms.

We expect more assistance from verifying and inspecting agencies. It still frequently happens that a survey of enterprises, kolkhozes, sovkhozes, and construction sites to determine scrap metal resources and to improve procedures in its collection and storage is not of a thorough, orderly nature, and it is not always done in a qualified manner. As a result they haul in to us for processing a mixture of common-grade and alloy scrap, cast iron and nonferrous metal waste.

One of the most important reasons for scrap metal losses is deficiencies in planning. The existing system of accountability is based only on the actually attained rate of procurement growth and inaccurately reflects depreciation scrap resources. Some managers keep accumulated waste metal "to have on hand." This is a gross violation of regulations.

Counterhauls are another problem. We are having trouble here overcoming the inertia of some of the enterprises of the Ministry of Tractor and Agricultural Machine Building, the Ministry of Construction, Road, and Municipal Machine Building, the Ministry of Machine Tool and Tool Building Industry, and the Ministry of Power Machine Building, which year after year schedule the hauling in of large quantities of scrap, in spite of the fact that they themselves deliver the same kind of scrap to Vtorchermet.

For example, an annual plan to deliver 88,700 tons of scrap metal was specified for the Izhorskiy Plant in Leningrad, while at the same time 176,200 tons of scrap of the same grade was allocated to this plant.

Although state standards exist for scrap, just as for other types of products, many enterprises which possess considerable resources of metallurgical raw materials do not order processing equipment and deliver waste metal which has not been sorted or prepared for remelting. Abusers include the plants of the USSR Ministry of Heavy and Transport Machine Building and the Ministry of Coal Industry, among which we could mention the Uzlovaya Kran Association in Tul'skaya Oblast and the Druzhkovka Machine Building Plant imeni 50th Anniversary of the Soviet Ukraine in Donetskaya Oblast. Our repeated appeals to deputy ministers R. Arutyunov and Ye. Krol' to take appropriate measures have unfortunately not altered the situation as yet.

There are also many difficulties with the delivery of scrap metal. The executive committees of local soviets, when siting secondary raw material delivery facilities, designate construction sites in areas difficult of access to the public and without service and utility lines. Or consider the following fact. Dozens of vessels removed from service in the Far East are lying around gathering rust in harbors and inlets. This fact is well known to the Primorskiy Kray Executive Committee, but for three years now they have not allocated a site for construction of a marine scrap and salvage yard.

The ferrous metallurgical industry has a reliable raw materials base, but requirements in iron ore, fluxes, refractories, and alloying elements are being met with increasingly greater material and labor expenditures year by year. It is for this reason so important fully to utilize secondary raw materials.

3024

CSO: 1842/121

## HEAT TREATMENT

UDC 620-194

### INFLUENCE OF HEAT TREATMENT ON CORROSION CRACKING OF TITANIUM ALLOYS AND DELAYED FRACTURE IN AIR

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 2, Mar-Apr 82 (manuscript received 4 Mar 81) pp 52-55

KOMISSARENKO, L. M., LUNIN, V. V. and MARICHEV, V. A., Institute of Physical Chemistry, USSR Academy of Sciences, Moscow

[Abstract] A study was made of the influence of various types of heat treatment on the tendency toward delayed fracture in air and corrosion cracking in a 2 m LiCl solution of VT5-1, VT20 and VT23 titanium alloys. VT20 and VT5-1 were studied in the hardened state (850°C, holding 30 minutes, quenching in water); annealed (850°C, holding 30 minutes, cooling in air) and as delivered (hot rolled plate 8-10 mm thick). VT23 was hardened from 800°C by quenching in water and aged at 500°C, 10 hours. Hardening increases the resistance of VT20 to corrosion cracking and delayed fracture in air. The same is true of VT5-1. VT23 has good corrosion cracking and delayed fracture resistance as delivered. Hardening and aging improves the strength of VT23 with  $\alpha+\beta$  structure, but makes it highly sensitive to corrosion cracking and delayed fracture in air. The fracture of this alloy changes from viscous to brittle after hardening and aging. Figures 3; references 7: all Russian.

[142-6508]

INFLUENCE OF HEAT TREATMENT ON DAMPING CAPACITY AND SHAPE MEMORY EFFECT IN  
TiNiFe ALLOY

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 26 Nov 79) pp 83-87

FAVSTOV, Yu. K. and CHERNOV, D. B., Kuybyshev

[Abstract] One method of differentiating the various stages in the complex, multistaged, reversible martensite transformation occurring in TiNi alloys is combined study of the shape memory effect and damping capacity on the same specimens. The present studies were performed on fatigue-type specimens of TiNiFe alloy after various heat treatments. Gage section diameter was 8 mm, length 50 mm. Heat treatment included hardening from 900°C in water and tempering at 400, 500 and 600°C for various times. The primary martensitic transformation occurs in a very narrow temperature interval and is accompanied by a great increase in the damping capacity of the alloy. The formation of a low temperature modification of martensite occurs upon further cooling of the alloy. A change in tempering conditions alone can greatly change the temperature intervals of direct and reverse martensitic transformation and the hysteresis of these transformations. Figures 5; references 4: 2 Russian, 2 Western.  
[130-6508]



## MECHANICAL PROPERTIES

UDC: 669.017.2

### MECHANICAL PROPERTIES OF MULTILAYER MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 82  
(manuscript received 5 Mar 81) pp 70-74

MAYBORODA, V. P., TREFILOV, V. I., YEZHOV, A. A., FIRSTOV, S. A., KOTOV, V. F.,  
SHVARTS, V. I., REBO, S. L. and IMENINNIK, V. G., Institute of Material  
Science Problems, Ukrainian Academy of Sciences

[Abstract] A study was made of the mechanical properties of multilayer composites produced by various methods and with various levels of purity. The composites consisted of steel plus 0.5 to 0.8 mass % carbon and 17 to 30 mass % copper. Specimens were tempered at 430°C to study the ratio of impact toughness of the steel and composite at lower hardnesses. By varying the thickness of the copper intermediate layer while retaining the thickness of the outer steel layers it was possible to change the first component of the work of fracture significantly. The composites had significantly greater impact toughness and strength than single-layer materials. The metallurgical method of manufacturing the materials improved the combined mechanical properties most. The increase in impact toughness apparently results from inhibition of cracks in the plastic components as well as the increase in strength of the hard component resulting from decreased layer thickness.

[145-6508]

UDC: 669.018

VANADIUM MODIFICATION OF SILICIDE MASTER ALLOYS FOR PLASMA COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 82  
(manuscript received 9 Feb 81) pp 46-50

TERENT'YEVA, V. S., BOYKOV, Ye. D. and KHOKHLACHEVA, G. M., Moscow Aviation Institute

[Abstract] Metallographic, microdurometric, x-ray structural, microscopic x-ray spectral and electronographic analyses were used to study the structure and heat resistance of silicide alloys in the Si-Ti-Cr system. Heat resistance tests were performed by continuous oxidation with subsequent periodic weighing in air at 1300°C for a total oxidation time of 100 hours. The microstructure of the alloys was found to be the same as in similar compositions without vanadium. The vanadium is concentrated in the refractory phase in the complex silicide (Cr, Ti, V) Si<sub>2</sub>. Vanadium alloying significantly delays oxidation of the alloys and changes the oxidation curve from parabolic to logarithmic. Figures 3; references 3: 2 Russian, 1 Western.  
[145-6508]

UDC: 621.762.5:669.29:539.3

STRUCTURAL AND PHASE CONVERSIONS OCCURRING IN SINTERED TITANIUM MATERIALS UPON FRICTION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 82  
(manuscript received 24 Mar 81) pp 66-70

RADOMYSEL'SKIY, I. D., KLIMENKO, V. N., PETROVA, A. M., MAMONOVA, A. A., and VARCHENKO, V. T., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] The influence of molybdenum on structural and phase conversions occurring on the friction surface of type IT-20 titanium material containing chromium and carbon at elevated temperatures is described. Studies were

performed on titanium specimens, IT-20 titanium alloy and the same alloy with added molybdenum based on electrolytic titanium powder, produced by cold pressing and subsequent vacuum sintering. Under friction conditions at room temperature the film of chemically adsorbed oxygen and nitrogen on the surface decreases the coefficient of friction of the material from 1.5 to 0.47 but does not prevent significant wear and erosion of the mating surfaces. At high temperatures the coefficient of friction drops to 0.23; wear rates are still high but surface scratching does not occur. Molybdenum is an effective modifying substance, the addition of which improves the wear resistance of the titanium material at elevated temperatures, from 250 to 550°C. Particularly when present as individual inclusions it helps to form strong films during friction in air containing primarily molybdenum oxides and hydroxides.  
[145-6508]

UDC: 532.6:669.018.25

#### MASS TRANSFER OF METAL MELTS IN SINTERED TITANIUM CARBIDE COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 82  
(manuscript received 25 Mar 81) pp 55-59

LISOVSKIY, A. F., Institute of Superhard Materials, Ukrainian Academy of Sciences

[Abstract] The relative contribution of diffusion and of migration is studied in the mass transfer of metal melts in titanium carbide-based composite materials. Specimens measuring 5 x 8 x 35 mm with not over 0.2% porosity were manufactured of titanium carbide containing 20.0 and 49.5% Ni, 19.5 and 51.3% Co by volume. The specimens were placed in a vacuum furnace, pressure 0.15 Pa, temperature 1370°C, placed in contact on the 5 x 8 mm face and held for 1500 seconds. The redistribution of nickel and cobalt was studied in combinations with 20% nickel and 20% cobalt and with 50% nickel and 50% cobalt, mass transfer occurred only by mutual diffusion, while in compositions with 20% nickel and 50% cobalt and with 50% nickel and 20% cobalt both diffusion and migration mechanisms were involved. Diffusion and migration mass transfer occurs in approximately equal fractions. Migration of the melted metal in sintered products results in significant structural changes, an increase in the content of binder metal, regrouping of refractory particles, etc.

Figures 3; references 12: 11 Russian, 1 Western.

[145-6508]

## LONG TERM HARDNESS OF ALLOYS IN V-TiN, V-ZrN and V-HfN SYSTEMS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 82  
(manuscript received 5 May 81) pp 95-99

BAN'KOVSKIY, O. I., BARABASH, O. M. and MOISEYEV, V. F., Institute of  
Material Science Problems, Ukrainian Academy of Sciences

[Abstract] A study is presented of the possibility of nitride hardening of vanadium and its alloys. Nitride hardening has a number of advantages over carbide hardening. The nitrides are thermodynamically more stable than the corresponding carbides at high temperatures. The structure and heat resistance of cast alloys in the V-TiN, V-ZrN and V-HfN quasi-binary were studied by determining the hardness after holding under a load of 1 kg for 1 hour at a predetermined temperature. The most promising of the vanadium alloys with nitride hardening studied for the development of heat resistant composites is that containing 3-6 vol.% nitride phase, composition (V, Ti) N. Figures 4; references 14: 10 Russian, 4 Western.  
[136-6508]

UDC: 621.762

## DIFFUSION SATURATION OF SINTERED IRON-TITANIUM MATERIALS WITH CARBON

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 82  
(manuscript received after revision 29 Sep 81) pp 87-91

NARVA, V. K., SALIBAYEV, N. T. and PERSHIKOVA, O. I., Moscow Institute of  
Steels and Alloys

[Abstract] A study was made of the process of diffusion saturation of materials based on iron alloyed with 5, 10 and 15 mass % Ti with carbon from sprinkled carbon black pressed at  $3 \cdot 10^8$  Pa. The specimen density was studied as a function of pressing pressure. Diffusion saturation was combined with sintering in some cases and performed after sintering in others. The specimens were sintered in a vacuum electric furnace at 1473-1523°K for 7,200 S for the alloy with 5% Ti, and at 1473-1573°K, 5,400 S for alloys with 10 and 15% Ti. Carbon saturation was performed in bulk lamp black, graphite cartridges, graphite tubular resistance furnace, in a current of hydrogen. The process of carbonization is found to be more rapid when combined with sintering. The distribution of hardness through the depth of the diffusion layer indicates more complete carbonization of surface layers. Increasing titanium content corresponds to increasing hardness of diffusion layers. Figures 5; references: 3; all Russian.  
[136-6508]

CHANGE IN FINE STRUCTURE OF TITANIUM DIBORIDE DURING SINTERING OF  
 $\text{TiB}_2$ -Fe(Mo) CERAMET

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 82  
(manuscript received 30 Jun 81) pp 32-35

YURIDITSKIY, B. Yu., PESIN, V. A. and ORDAN'YAN, S. S., Leningrad Institute  
of Technology; All-Union Scientific Research Institute of Abrasives and  
Grinding

[Abstract] A study is presented of changes in the fine structure of  $\text{TiB}_2$  in  
the process of vibration grinding and subsequent liquid-phase sintering.  
Phase analysis indicated the formation of slight quantities of  $\text{Fe}_2\text{Mo}$  and a  
ternary compound  $\text{Mo}_2\text{FeB}_4$  independently of specific sintering conditions.  
Typical sections show  $\text{TiB}_2$  particles which are nonrecrystallized surrounded  
by layers of smaller particles which are recrystallized. Figures 2;  
references 7: 5 Russian, 2 Western.  
[136-6508]

## SEMICONDUCTOR TECHNOLOGY

### CRYSTALLIZATION OF SEMICONDUCTOR MELTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian  
Vol 18, No 4, Apr 82 (manuscript received 7 Apr 81) pp 557-559

GLAZOV, V. M. and YATMANOV, Yu. V., Moscow Institute of Electronic Technology

[Abstract] A study is made of the process of crystallization of semiconductor materials at superfast cooling rates. The method used is to throw droplets of the melt at a certain angle and at high speed against the surface of a rapidly rotating copper cylinder. Droplet formation and acceleration are achieved by creating a shock wave in an inert gas by connecting the chamber of melt to a high pressure chamber. The shock wave breaks the melt into droplets measuring 1 to 40  $\mu\text{m}$  and accelerates them to approximately 300 m/s. The present studies on crystallization of Bi-Se alloys produced flakes 0.1 to 30  $\mu\text{m}$  thick, cooling rate  $10^6$ - $10^8$  K/s. Diffractograms are presented of an alloy with 58 at.% Se crystallized in the installation from a temperature 50 to 70°K higher than the melting point and of the same alloy after annealing at 570°K for 60 hours. Annealing changes the diffraction picture appreciably, leading to significant structural changes in the semiconductor alloy after rapid cooling. Figures 2; references 10: 7 Russian, 3 Western.

[135-6508]

## SUPERHARD MATERIALS

UDC: 539.374

### CRACK RESISTANCE OF COMPOSITE MATERIALS BASED ON HARD ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 82  
(manuscript received after revision 29 Jul 81) pp 88-93

DEVIN, L. N., MAYSTRENKO, A. L., SIMKIN, E. S., SKLYAR, S. I. and TSYPIN, N.V.,  
Institute of Superhard Materials, Ukrainian Academy of Sciences

[Abstract] The Institute of Superhard Materials has developed a method for determining the resistance of superhard composite materials to the development of fractures and has performed studies of the influence of initial synthetic diamond characteristics on the crack resistance of composites based on tungsten-cobalt group hard alloys. A gravity hammer with a freely falling weight has been developed to test specimens under dynamic loading at various speeds. Studies were performed on disk specimens 10 mm in diameter with a penetrating central notch not over 0.08 mm in width, ground by a diamond tool to a size of 2.5 mm. The diamond grains were found to influence significantly the crack resistance, creating obstacles to the path of advancement of cracks. The greatest resistance was produced by more circular diamond grains with significant impurity content. The strength of the diamond grains has little influence on crack resistance in impact loading. Figures 5; references 8: 7 Russian, 1 Western.  
[145-6508]

## TITANIUM

UDC: 620.193

### PHYSICAL-CHEMICAL STUDIES OF TITANIUM-BASED ALLOYS RAPIDLY COOLED FROM LIQUID STATE

Moscow ZASHCHITA METALLOV in Russian Vol 18, No 3, May-Jun 82  
(manuscript received 19 Jun 81) pp 323-329

TOMASHOV, N. D., KOVNERISTYY, Yu. K., OSIPOV, E. K., SKVORTSOVA, I. B. and TROMIMOVA, Ye. A., Institute of Physical Chemistry, USSR Academy of Sciences; Institute of Metallurgy, USSR Academy of Sciences

[Abstract] A study was made of the influence of cooling rate from the liquid state on the structure, resistive and electrochemical properties of a number of 2- and 3-component titanium-based alloys. Two-component alloys contained titanium and nickel; 3-component alloys also contained boron or silicon. A 2-3 cm<sup>3</sup> charge was melted in an induction heater in the suspended state in purified helium, then heated to 250-300° above the liquidus point, the magnetic field was turned off and the melt poured into a funnel from which it fell as a continuous stream onto the outer surface of a copper cylinder rotating at 5000-10,000 rpm, achieving cooling speeds of  $5 \cdot 10^5$ - $10^6$ °C/s. Flat strips 8-100 μm thick and 1-5 mm wide were produced. The influence of the boron and silicon on the tendency of Ti-Ni alloys toward amorphous hardening and their plastic characteristics was studied. Amorphous boron and single-crystal silicon of high purity were used. The addition of 10 at.% boron or silicon reduces the critical cooling speed and greatly expands the concentration intervals over which amorphous structures are formed. Figures 4; references 9: 2 Russian, 7 Western.

[143-6508]



## INFLUENCE OF LOCAL HEATING ON CORROSION FATIGUE STRENGTH OF TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 82 pp 29-31

ZAIKIN, V. M., engineer

[Abstract] Testing of specimens for corrosion and fatigue strength yields results closest to actual usage conditions. Therefore to establish the effective application of various methods of local heating in the process of thermal nonimpact straightening, studies were performed on the corrosion-fatigue strength of a titanium alloy. The studies were performed on experimental structures made of a titanium alloy with yield point 660 MPa and short-term tensile strength 730 MPa, using experimental structures assembled of plates 10 mm thick reinforced with transverse elements welded together and welded to the plates by manual argon arc welding. The welding deformation of the experimental structures was eliminated by thermal nonimpact straightening. It was found that thermal nonimpact straightening by local heating with an acetylene-oxygen flame reduces the corrosion-fatigue resistance of the titanium alloy by 5, 9 and 50 MPa (18-40%) when the flame is applied to the idle roller, idle pass and workpiece. The surface hardening of heat sections and base metal can increase corrosion fatigue resistance by a factor of 1.5-2. Use of optimal thermal nonimpact straightening conditions for welded structures can decrease the labor consumption of straightening, increase productivity, improve conditions of labor and assure reliability and efficiency of welded structures made of titanium alloy both in air and in corrosive media. [126-6508]

UDC: 669.295:548.33:539.124.6

## ANNIHILATION OF POSITRONS IN TITANIUM-ALUMINUM AND TITANIUM-TIN ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 53, No 4, Apr 82 (manuscript received 19 Jan 81, in final form 14 Apr 81) pp 825-827

DEKHTYAR, I. Ya., FEDCHENKO, R. G., KUPCHISHIN, A. I., MIKASHEV, K. M. and RAFALOVSKIY, V. A., Institute of Metal Physics, Ukrainian Academy of Sciences

[Abstract] It has been suggested that new phase seeds in Ti-Al and Ti-Sn alloys heated to the  $\alpha \rightarrow \beta$  conversion point act as thermalized positron capture centers. For further clarification of the behavior of the positrons in titanium based alloys, this article undertook a study of electron-positron annihilation in Ti-Al and Ti-Sn deformed and annealed alloys. As in the

case of Ti-Fe and Ti-Zr systems, the anomalous behavior of annihilation parameters apparently results from the fact that plastic deformation, even at room temperature, initiates polymorphous conversion. The restructuring of the lattice is accompanied by the formation of new interphase boundaries with vacancy-dislocation nature. Plastic deformation should then cause the creation of defects, the capture potential of which for positrons is much greater than that of simple defects. Figures 2; references 6: 3 Russian, 3 Western. [137-6508]

## WELDING

UDC: 621.791.72:621.373.826.002

### OPTIMIZATION OF FOCAL PLANE POSITION DURING LASER WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 82  
(manuscript received 29 Sep 81; in final form 24 Nov 81) pp 62-64

VOLOBUYEV, Yu. V., engineer, FEDOROV, V. G., candidate of technical sciences, GRIGOR'YANTS, A. G., doctor of technical sciences, and IVANOV, V. V., candidate of technical sciences, Moscow Higher Technical School imeni N. E. Bauman; ASTAKHOV, A. V. and BARANOV, G. A., candidates of technical sciences, Scientific Research Institute of Electrophysical Apparatus imeni D. V. Yefremov

[Abstract] Experiments were performed using an electric discharge "Izhora-M" laser generating infrared radiation at  $\lambda=10.6 \mu\text{m}$ , divergence  $2.8 \cdot 10^{-3}$  rad, maximum power  $17 \cdot 10^3$  W continuous generation, focused by optical systems with focal lengths of 0.80 and 0.44 mm. The greatest power density is  $14 \cdot 10^9$  W/m<sup>2</sup>. By the use of a short focus optical system, the branches of the curve can be made to drop more steeply on both sides of the extreme of melting depth. Studying the melting of a stepped specimen at a constant rate with various radiation power densities, the variation in melting depth as a function of focal plane position relative to the surface of the metal was determined. The melting depth at  $14 \cdot 10^9$  W/m<sup>2</sup> is determined by the power density for the range of focal lengths tested. The position of the focal plane relative to the surface of the metal must be adjusted to produce the maximum melting depth in accordance with the power density: as power density increases the focal plane must be further below the surface of the metal. A nomogram is developed which can be used to select the basic technological parameters of laser welding based on the desired depth of melting. Figures 3; references 7:

6 Russian, 1 Western.

[138-6508]

## ELECTROSLAG WELDING OF HIGH PRESSURE VESSEL BOTTOM BLANKS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 82  
(manuscript received 7 Dec 81) pp 52-53

MAKAROV, V. M., doctor of technical sciences, KORNILOV, F. N. and  
BATANOGOV, F. A., engineers, Uralkhimmash Production Association

[Abstract] Blanks for welding at Uralkhimmash are mechanically worked with a tolerance of 15 mm in each direction for final working after welding. The blanks are welded in the vertical position by electros slag welding methods. Welding is performed by three type 08Kh3G2SM wires 3 mm in diameter using an A-535 welding machine in a slag bath consisting of a mixture of AN-8M and 48-OF-6 fused fluxes, 1:1 by volume. After welding, the blanks are placed in a furnace heated to 350-400°C without allowing the blanks to cool below 200°C in the seam area for high tempering. The mechanical properties of the welded joints produced are presented. Figures 1.  
[138-6508]

## COMPARATIVE ESTIMATE OF INFLUENCE OF TITANIUM AND ALUMINUM ON PROPERTIES OF HEAT RESISTANT METAL MELTED BY ARGON ARC METHOD

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 82 pp 22-25

SOROKIN, L. I., candidate of technical sciences

[Abstract] Results are presented from a study of the influence of titanium and aluminum on the composition and nature of formation of a seam, resistance to the formation of hot cracks and mechanical properties of metal surfaced by the argon arc method. Experimental melts of Kh15N70K10B3 and Kh15N75K10 were used, additionally alloyed (up to 3.5-4%) by titanium and aluminum, melted in a vacuum-induction furnace. Plates 10 mm thick were then cast, mechanically worked, rolled to a thickness of 3 mm, etched and broken into bars 3 x 3 mm in size. Mechanical properties were determined on specimens made of multi-layer metals produced by using bars from experimental melts by the argon arc method in a copper mold. The hot crack formation tendency, content of alloying elements in the surfaced metal and composition of nonmetallic inclusions were determined. It was found that the heat resistance of the seam metal could be increased by alloying the Kh15N75K10B3 alloy with aluminum (up to 2%) which, in comparison to titanium, improves the formation of the seam and results in less decrease in hot crack formation resistance with identical hardening of the surface metal. Figures 6; references 8: all Russian.  
[126-6508]

## MISCELLANEOUS

### PREVENTING HYDROGEN WEAR OF METAL

Moscow PRAVDA in Russian 28 Apr 82 p 3

[Article by Doctor of Technical Sciences Professor D. Garkunov and Candidate of Technical Sciences A. Polyakov, Moscow: "Flying Enemy of Metal"]

[Text] Hydrogen is the first element of the universe. It is the first because it contains a minimum number of electrons and because it serves as the basic "building block" of the universe. On our planet it is present in almost all organic and many inorganic chemical compounds.

The hydrogen ion, a proton, is especially active. It has no electrons around its nucleus, and its size is 100,000 times smaller than that of the ions of other elements. Interactions between a proton and other molecules are "simplified" in the absence of electrons, with a reduced number of obstacles in its passage from compound to compound.

What are the consequences of this activity? In metal, for example, hydrogen behaves like sand between machine parts. It causes brittleness and promotes the occurrence of microscopic cracks. Its action is similar to wedges which are driven into the nucleation centers of defects, which always exist in metal. This frequently leads to failure of critical stressed parts -- turbine shafts, engine crankshafts, and steel tanks.

Hydrogen gets into metal during production as a result of corrosion, as well as during electroplating processes, such as chrome plating, welding, etching, and heat treatment. The effect of hydrogen on the mechanical properties of metals is being investigated in all industrially developed countries, and means are being sought to protect material against undesirable effects. Hydrogen is removed from components (following chromium plating, for example) by heating and holding at a temperature of about 250° Celsius. Hydrogen is "lifted" from a deep location to the surface (it possesses the property of concentrating at heated locations) and is removed from the metal.

But in many instances the surface layer of metal in which there should be an infinitesimal quantity of hydrogen experiences failure because a hundred times more hydrogen than normal has accumulated in it. How does this happen? Fifteen years ago the authors of this article established a new phenomenon in the field of physics of friction -- self-organization of failure during friction

(hydrogen wear). It is termed self-organization because the process of wear consists of several interlinked sequential stages.

Hydrogen is always released during friction. There are many reasons for this. The main reason is the ease of proton migration. In the contact zone lubricant, fuel, plastic and other hydrocarbons, or simply water from the air, can release hydrogen. It does not propagate throughout the entire volume of the machine part but concentrates in the heating zone of a layer of steel during friction. A so-called hydridophilic -- water-loving -- zone is created, which absorbs hydrogen tens of times more intensively than a zone not subjected to friction.

Hydrogen protons can acquire electrons in crack nucleation centers and form atoms, and subsequently molecules. Increasing in size, they thrust against the surface with great force at the site of a defect. Cracks subsequently merge, and the outer layer may disintegrate into a powder.

The areas of occurrence of hydrogen wear are extensive. Practically all rubbing surfaces of parts made of steel, cast iron, titanium and other metallic materials contain an elevated quantity of hydrogen, and sooner or later this has an effect, especially in a damp or cold climate. We know, for example, that in the North equipment wears out several times faster than in the temperate zone. This is due to the fact that at low temperatures and elevated humidity, hydrogen exerts more destructive effect on the surface of a machine part.

It has now been firmly established that friction-contact parts have a service life one third to one half normal in hydrogen-containing environments and in pure hydrogen. This will particularly affect the life of engines, since it is planned to convert engines in the not too distant future to hydrogen fuel. This means that we must seek a means of protection in advance.

But work in this area of investigation is already producing appreciable economic effect. The All-Union Scientific Research and Design-Technological Institute of Industrial Asbestos Products, for example, several years ago developed a new friction material which is not subject to hydrogen wear. As a result automobile brake linings now last twice as long. Employment of this material just at the Automotive Plant imeni Lenin Komsomol results in annual savings of more than one and a half million rubles. That same institute also came up with a new friction material for trucks.

A unique method of extending the service life of brake shoes and railcar wheels was developed by the people at the Rostov Rail Transport Institute. They established that if a certain quantity of plastic of different chemical composition is added to the plastic of a brake shoe material, in the process of friction a steel band in contact can be charged with positively-charged electricity. It will also repel positively-charged hydrogen ions, and the service life of the friction pair will increase.

The Kiev Institute of Civil Aviation Engineers developed, jointly with the Institute of Problems of Materials Science, under the direction of UkSSR

Academy of Sciences Corresponding Member A. F. Aksenov, an alloy for rubbing machine parts which operate in water. This alloy does not absorb hydrogen, and its resistance to wear is several times greater.

Investigations of hydrogen wear have just begun. As is evident from the cited examples, this is a complex and interbranch problem. Its solution is possible only with the participation of scientists of various areas of specialization -- metallurgists, physical metallurgists, physicists, chemists, and specialists in machinery friction and wear. Appropriate research must be conducted according to a unified plan. The USSR Academy of Sciences Institute of Theoretical Engineering has specified a combined five-year plan of research on this problem. A number of scientific and industrial organizations have been enlisted in implementing this plan.

This is praiseworthy, but research is being conducted on personal initiative and on a voluntary basis by individual specialists and could drag on for many years.

It is high time to solve the problem of wear more efficiently. In our opinion it is necessary to organize a special laboratory dealing with protecting machine parts from hydrogen wear. The USSR State Committee for Science and Technology should see that institutes of industrial ministries plan research and development in the area of hydrogen wear applicable to their own types of products, and methods of combating this harmful phenomenon.

We shall note that the phenomenon of hydrogen wear was established in this country. Scientists of many countries are now studying it. Delay here is intolerable. Protection of machinery against accelerated wear connected with hydrogen can and should produce considerable savings in machine building.

3024

CSO: 1842/122

UDC: 546:289-621.315.592

PRODUCTION, ELECTRIC AND PHOTOELECTRIC PROPERTIES OF THREADLIKE GeS  
CRYSTALS DOPED WITH INDIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian  
Vol 18, No 4, Apr 82 (manuscript received 22 Jan 81) pp 544-548

BLETSKAN, D. I. and INDUS, Ye. Yu., Uzhgorod State University

[Abstract] The conditions of production, results of combined study of morphology, electrical and photoelectric properties of GeS:In threadlike crystals are presented. Polycrystalline GeS doped with In was obtained by direct melting of Ge and S in stoichiometric ratios plus indium at 0.5 mass %. Metallographic microscopic studies were performed, and the temperature variation of conductivity, lux-ampere characteristics and photoconductivity spectra were determined. The In impurity is found to be significant in formation of the habitus of the crystals and in the physical properties. When linearly polarized light shines on the crystals the photosensitivity varies periodically as a function of the angle between the electrical vector of the light wave and the crystalline axes a and b. Figures 4; references 7: all Russian.  
[135-6508]

UDC: 532.13;669.01

INGOT CRYSTALLIZATION CONTROL IN PRODUCTION OF REINFORCED QUASIMONOLITHIC  
METAL (RQM)

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE  
I TEKHNIЧЕСKIYE NAUKI in Russian No 3, Mar 82 (manuscript received 13 Aug 81)  
pp 81-84

SAYENKO, V. Ya., SAMOYLOVICH, Yu. A., MEDOVAR, L. B. and US, V. I.,  
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Sciences

[Abstract] A new process has been developed at the authors' institute for the  
production of reinforced steel as thin or thick sheets, including strips for



the production of high pressure welded pipe. Under static loading the product acts as an ordinary monolithic, homogeneous material; under impact loading it acts as a multilayer product, capable of resisting both brittle and viscous fracture. The simplest method of producing RQM is to reinforce the ingot as the mold is filled with liquid steel, then roll it on a strip rolling mill. This requires selection of the optimal relationship of characteristics of reinforcing plates, their number and placement, ingot size and pouring conditions. This problem is solved by a combination of experimental thermal analysis and mathematical modeling of the process of crystallization. A single reinforcing plate 240 mm thick reduces ingot crystallization time from 3 hours to 1/2 hour, while 4 plates, each 18 mm thick, reduce crystallization time from 3 hours to 2 hours. Figures 2; references 2: both Russian. [131-6508]

UDC: 669.15:(669.869.293.855)

#### YTTRIUM-NIOBIUM-IRON AND CERIUM-NIOBIUM-IRON SYSTEM

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNIЧЕСKIYE NAUKI in Russian No 3, Mar 82 (manuscript received 13 Aug 81) pp 70-71

BODAK, O. I. and BEREZYUK, D. A., L'vov State University

[Abstract] Specimens of the 3-component systems studied were melted in an electric arc furnace in an atmosphere of purified argon, annealed in evacuated quartz ampules at 1070°K for 3,000 hours and hardened in cold water. X-ray phase analysis was performed, confirming the data in the literature on the stoichiometry and crystalline structure of the binary compounds formed in the systems. Phase diagrams of the systems at 1070°K were constructed. No ternary compounds are formed, the solubility of Y and of Ce in Nb-Fe compounds is practically 0. The solubility of Nb in {Y, Ce}-Fe systems is low. Two-phase equilibria with Y, Ce and compounds in the system {Y, Ce}-Fe form NbFe<sub>2</sub>. Figures 1; references 6: 5 Russian, 1 Western. [131-6508]

# INFLUENCE OF ENERGY INPUT CONDITIONS ON MECHANICAL DAMAGE TO VARIOUS CLASSES OF SOLIDS BY POWERFUL ELECTRON BEAM PULSES (REVIEW)

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 10 Nov 80) pp 15-23

BALASHOV, A. P., SELEZNEV, S. B. and KOGAY, L. N., Moscow

[Abstract] Electron accelerators with total beam energies of several MJ and powers of  $10^{13}$ - $10^{14}$  W per pulse have been created, and can be used to heat solid targets to thermonuclear temperatures, perform structural, chemical and phase transitions and obtain new materials, as well as perform mechanical testing, electron pumping of lasers, creation of highly intense x-ray sources, and for the study of radiation effects. One interesting area using these devices is the study of the disintegration of solids bombarded with powerful electron beams as in the working of rock, diamond, rubies and spinels. This review discusses the influence of various factors related to the specifics of the specimens studied and experimental conditions on the mechanical damage done to materials by powerful pulses of electrons. Specimens of various classes and thicknesses are covered. The influence of preliminary bombardment, defects in the materials, temperature and pulse length is discussed. Data are presented on the influence of factors related to the specifics of the specimens and bombardment conditions. It is concluded that the mechanism of fracture of solid bodies of various classes is different. The greatest number of works in the literature have been dedicated to ionic crystals, in which two fracture mechanisms occur. The fracture of semiconductor crystals and glasses has been studied little and requires further experimental and theoretical study. The fracture of metals when exposed to powerful electron beams results from thermoelastic and shock waves. Figures 4; references 42: 34 Russian, 8 Western.  
[130-6508]

UDC: 621.791.85

## PASSAGE OF ELECTRON BEAMS THROUGH PLATES OF MATERIALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 4 Apr 80) pp 9-14

MEL'KER, A. I., ROMANOV, S. N. and TOKMAKOV, I. L., Leningrad

[Abstract] The Monte Carlo method is used to calculate the angular and energy characteristics of back-scattered electrons and electrons passing through a flat specimen, with an initial electron energy of up to 2 MeV, as well as the

distribution of absorbed energy through the thickness of the plate. Calculations were based on a plan of successive collisions, since this method uses the fewest a priori assumptions, and the integral characteristics are calculated on the basis of first principles using the statistics of elementary events. The calculation algorithm is described, utilizing a computer program called HELEN, similar to a program studied in an earlier work by the same authors. The main sections of the algorithm are initial data input, composition of supplementary tables, calculation of electron trajectory in matter, setting of boundary conditions and adjustment, computation of problems related to determination of the type of scattering, and successive computation of the distribution of absorbed energy and electrons. It is found that the influence of plate thickness on the change in the energy spectrum of the back-scattered electrons is related to an increase in the share of  $\delta$  electrons. It is shown that the zone of disintegration in aluminum formed upon bombardment with relativistic electrons does not coincide with the zone of maximum energy absorption. Figures 5; references 12: 7 Russian, 5 Western.

[130-6508]

UDC: 533.92:661.55

#### INFLUENCE OF SYNTHESIS CONDITIONS ON COMPOSITION AND DISPERSION OF TITANIUM AND VANADIUM NITRIDE POWDERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 13 Apr 79) pp 24-29

TROITSKIY, V. N., BERESTENKO, V. I. and GUROV, S. V., Moscow

[Abstract] An experimental study is presented of the effect of various technological process factors on the composition and dispersion of vanadium and titanium nitride powders produced. The primary technological factor determining the concentration of the system is the quantity of initial tetrachloride introduced to the reactor. The experimental data were processed by construction of partial functional equations relating the dispersion of the powders produced (specific surface) to process factors. Such factors as total degree of transformation of tetrachloride and yield of nitride are important in producing powders of various particle sizes. The curve of change of specific surface of the nitride powders as a function of tetrachloride consumption shows a clear minimum in the area of 1 to 2 g/min of tetrachloride powder. Minimum particle size is observed with axial input of the reagents to the reaction zone. Particle size of vanadium nitride depends little on temperature conditions in the plasma chemical reactor. Figures 3; references 8: 7 Russian, 1 Western.

[130-6508]

## SUPERFINE INTERACTIONS UPON MANIFESTATION OF SHAPE MEMORY EFFECT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 12 Jul 79) pp 121-123

PROSKURIN, V. Yu., Sverdlovsk

[Abstract] The Mossbauer spectroscopy method is used to determine the change in superfine fields in  $\text{Fe}^{57}$  nuclei upon appearance of the shape memory effect in FeNi alloys. Experimental data are presented on changes in superfine structure parameters of the Mossbauer spectra related to the appearance of the shape memory effect. Studies were performed on FeNi alloys in the 25.5-31.3 wt.% Ni concentration range. Superfine fields were studied in four main stages of the deformation thermal cycle related to the shape memory effect: predeformation, following deformation, following heating to  $300^{\circ}\text{C}$  and following completion of shape recovery upon heating to  $650^{\circ}\text{C}$ . Studies of the superfine structure produced information on the nature and changes of local physical fields in the nuclei of the substances and may facilitate explanation of the microscopic mechanisms of the shape memory effect. Figures 2; references 6: all Russian.  
[130-6508]

UDC: 678.067-419.8:677.529

## FLUORIDATED-SURFACE CARBON FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 82  
(manuscript received 26 Sep 79) pp 108-115

KOBETS, L. P., POLYAKOVA, N. V., CHUBAROVA, M. A., KHAKIMOVA, D. K. and FIALKOV, A. S., Moscow

[Abstract] A study is performed by methods of physical and chemical analysis of the properties of carbon fibers with various fluorine contents. The fibers were produced by heat treatment at temperatures up to  $1200$ ,  $1900$  and  $2100^{\circ}\text{C}$ , as well as fibers treated up to  $2800^{\circ}\text{C}$  and containing boron inner structure. Density, strength and modulus of elasticity in extension were determined. Tensile strength and modulus of elasticity were found to pass through a maximum corresponding to 6-8 wt.% fluorine then drop sharply. The tensile strength maximum was more sharply expressed for the  $2100^{\circ}$  fibers than for the  $1900^{\circ}$  fibers. X-ray structural analysis indicates that there is no significant correlation between the texture of the carbon fibers and the fluorine content up to 17 wt.%, which is confirmed by mechanical testing. Heat treatment under a vacuum results in degassing of CO with a maximum of  $350$ - $650^{\circ}\text{C}$ . The process

is more intense in nitrogen at higher temperatures. The proposed carbon fiber structure is not inconsistent with a model of a highly oriented shell and less oriented core. With higher heat treatment temperatures the fibrillar structure is transformed to a laminar structure, accelerated by the addition of boron and crystallization of quasiamorphous carbon. Figures 5; references 8:

5 Russian, 3 Western.

[130-6508]

UDC: 621.02.268

# STUDY AND OPTIMIZATION OF GRINDING CONDITIONS IN ORDER TO INCREASE FRETTING RESISTANCE OF CHROME-PLATED STEELS

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 18, No 2, Mar-Apr 82 (manuscript received 4 May 81) pp 55-59

ALYAB'YEV, A. Ya., VENEDIKTOV, V. A. and KAZIMIRCHIK, Yu. A., Kiev Civil Aviation Engineering Institute

[Abstract] The process of grinding plus surface plastic deformation improves the wear resistance and cyclical strength of chrome-plated parts by increasing the hardness of the coating, yield and elasticity points, forming residual compressive stresses and expanding the load-bearing surface. Mathematical models are constructed for various abrasive disks and grinding fluids to determine the optimal grinding conditions to improve the fretting resistance of chrome-plated steels. The primary requirement which must be placed on grinding of chrome-plated steels is maximization of the microhardness of coatings for a given range of roughness. A grinding disk type 25A25PSM26K5 and akvol-10 cutting fluid produced the best fretting resistance. Figures 4; references 7: all Russian.

[142-6508]

CSO: 1842

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